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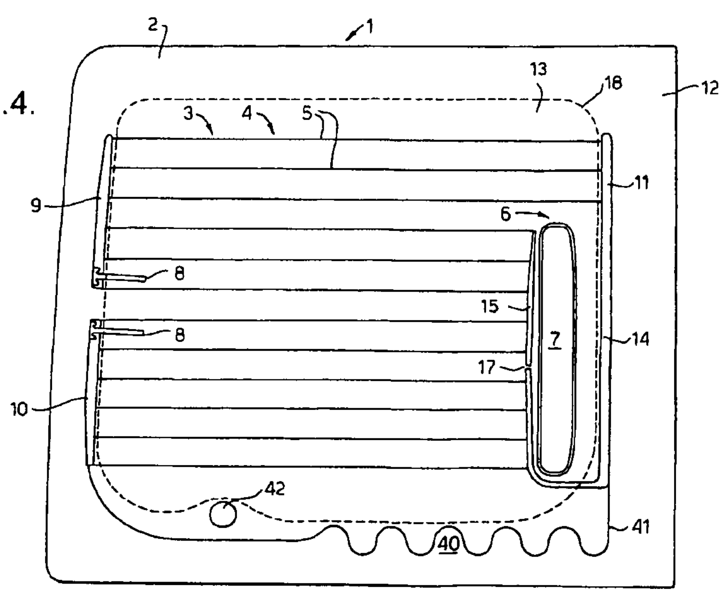
(54) Electrically heated window

(57) The window 1 has a busbar 11 comprising two portions of different width to allow an item of equipment, such as a lamp 7, to be accommodated on the window without the busbar arrangement detracting from the appearance of the window. A first, relatively narrow, busbar portion 15 allows part of a heating element 3 to terminate without extending into an area 6 selected for the lamp, and a second, relatively wide, busbar portion 14 is connected so as to reduce the electric current which flows through the narrow portion. The window may be for a vehicle, and preferably, only the narrow busbar portion is visible from outside the vehicle. The busbar 11 may be divided into two separate busbars, and a further heated area 40 may be provided where a window wiper may rest when not in use.

Fig.4.



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Description

The present invention relates to an electrically heated window, and more particularly to such a window which is heated by the passage of electric current through a resistive heating element disposed on the window.

Such resistive heating elements are often provided on a window for the purpose of restoring or maintaining vision through the window where it has been, or may be, reduced by condensation, frost, ice or snow. Terms such as "demisting", "defogging" or "deicing" are often used to describe the action of the heating element, and such windows have found particular application in vehicles, especially road vehicles, although their use is not limited thereto. Applications also exist in the doors of freezer display cabinets, and in windows for ships, trains and aircraft, for example.

Obviously, the area of the window heated by the heating element (the "heated area") needs to cover the area through which it is desired to restore or maintain vision (the "vision area"). This generally comprises a substantial part of the window, and in some applications it may comprise the whole of the transparent portion of the window (some windows having an opaque portion for aesthetic or other reasons). Resistive heating elements are also used to provide a heated area where a window wiper may rest when not in use, to prevent the wiper freezing to the window in cold conditions. Such an area is generally termed a heater wiper parking area, and it may add to the area heated for reasons of maintaining vision; alternatively a heated wiper parking area may be provided on its own in which case the heated area is smaller.

The heating element may comprise a thin transparent electrically conductive layer (such as a coating) on the window, or it may comprise an array of fine electrical conductors which extend across the window. The conductors may be fine wires, or alternatively lines printed in an electrically conductive ink. Electrical connection to the heating element is normally made by wider conductors known as busbars, which are adapted to carry substantial currents.

At its simplest, an electrically heated window as herein referred to may comprise a heating element and a pair of spaced opposed busbars, normally one on each of two opposed sides of a face of the window, with the heating element extending between them over the vision area. Electrical connection to an external power source, for example the wiring loom of a vehicle, may be made by plug and socket connectors of known type, the plug part of which is generally soldered to the busbar.

More complicated circuits are known, comprising a number of resistive heating elements. For instance, US 5,182,431 discloses an electrically heated window having at least three heating elements, at least one of which may be heated faster and to a higher temperature than the others. The various heating elements are connected in series by busbars.

In all such heating circuits, it is important to ensure that various technical and safety requirements are met, e.g. that the power density falls within acceptable limits, or that the resistance of the various parts of the circuit is appropriate. For example, if the power density is too low in any part of the heated area, that part of the heating element will not fulfil its intended function. Conversely, when the power density is too high, over a substantial area, the power consumption of the circuit may impose an excessive load on the vehicle's electrical system (particularly its generator). Furthermore, it is a widespread safety requirement that in use no exposed part of the circuit may exceed a temperature of 70°C. In particular, a high resistance portion of a busbar that is carrying a considerable current is likely to overheat and constitute a danger, e.g. to the occupants of a vehicle, as well as consume power which could more usefully be dissipated elsewhere, such as in the vision area.

As a result, designers of such heating circuits seek to ensure that all the busbars in the circuit are of sufficiently low resistance for the current intended to be carried. In practice, as the thickness of the busbar is limited by various factors, this means providing busbars of adequate width, although wide busbars are considered to detract from the appearance of the window.

There is a general trend towards greater functionality in windows, and this may entail the provision of an increasing number of items of additional equipment on or adjacent the window. For instance, apart from the heating elements described above, the window may carry antennae, alarm circuits, lamps, solar cells or window wipers (possibly including a wiper motor). A conflict may arise regarding the positioning of these items on the window, and this may pose particular problems in the context of electrically heated windows, since the heating element, by its very nature, generally extends over most of the transparent portion of the window. Moreover, a technical incompatibility may exist between the heating element and the item of equipment to be provided on the window. For instance, heat may damage the seals of a lamp or solar cell, and reactions may occur which additionally damage the glazing material. Alternatively, the electric current carried by the heating element may adversely affect an electrical accessory provided on the window.

The problem of accommodating an additional item of equipment, when that item is to be positioned within the area that would otherwise be heated, can arise on various different types of window, e.g. windows for buildings, vehicles or other equipment If an item of equipment is to be positioned within an area generally defined by the busbars in combination with the outermost parts of the heating element, it is usually desirable to modify the heating element and associated busbars to make space for the item. To be more precise, an area is selected for the item and is maintained free from conductors or a

conducting layer, thereby allowing the additional item of equipment to be provided in the selected area, which is unheated. While a simple solution may appear to be to reposition the appropriate busbar so as to restrict the extent of the heated area, this is frequently not acceptable because it entails positioning the busbar in a highly visible position, where it looks unattractive and also impairs vision through the window.

It would therefore be desirable to be able to configure the heating element(s) and associated connections of electrically heated windows so as to leave a selected area of the window free, e.g. for the provision of an additional item of equipment, while still providing a window that is acceptable both aesthetically and technically.

It has now been found that it is possible to provide such a window by using busbar portions of different widths in appropriate combinations.

The present invention accordingly provides an electrically heated window comprising a pane of glazing material, at least two spaced busbars disposed on the pane and a resistive heating element extending over the pane from one busbar to the other busbar, said busbars connecting the heating element to an external power source, the window being heated by the passage of current through the heating element, characterised in that the heating element is arranged to leave a selected area of the window unheated, and that at least one of the busbars comprises at least two portions whereby the first portion of the busbar is narrow relative to the second portion, that the relatively narrow busbar portion extends adjacent the selected area and part of the heating element is connected to the relatively narrow busbar portion so that it terminates without extending into the selected area, and that the relatively wide busbar portion is connected so as to reduce the electric current which flows through the relatively narrow busbar portion.

The relatively wide busbar portion is connected so as to reduce the current which would flow through the relatively narrow busbar portion if the relatively wide busbar portions were omitted and all the conductors were connected to the relatively narrow busbar portion, as is explained in more detail below.

An important advantage of the invention is the fact that it makes the use of a relatively narrow busbar portion possible. This is because the relatively wide busbar portion, by reducing the current in the narrow portion, alleviates overheating of the narrow portion due to its higher resistance. The at least one busbar comprising narrow and wide portions may comprise two separate busbars, one of the busbars being at least partly connected in parallel with the other busbar in electrical terms.

Furthermore, when the at least one busbar is divided into two busbars, it is not necessarily the case that the relatively narrow busbar portion forms one busbar and the relatively wide busbar portion forms the other busbar. It is in fact frequently preferable that one of the busbars includes only part of the narrow portion, and the other busbar includes all of the wide portion as well as the remaining part of the narrow portion. This arrangement advantageously enables the busbar that is wholly narrow (the "narrow busbar") to be kept short (i.e. shorter than the length of the two parts of the relatively narrow busbar portion put together), and thereby reduce its resistance.

The window frequently comprises an opaque portion as well as a transparent portion; the opaque portion may be in the form of a border around the transparent portion. It is preferable if the relatively wide busbar portion is disposed substantially on the opaque portion of the window, because in that position it has no adverse effect on the appearance of the window or vision through it. Alternatively, in many cases it is acceptable if the relatively wide busbar portion extends adjacent the opaque portion, for in this position the effect on the appearance of the window and vision through it is minimal. Normally the relatively narrow busbar portion is disposed substantially on the transparent portion, because its presence there detracts from the appearance of the window to a minimal extent.

For aesthetic reasons it is preferable that the two parts of the relatively narrow busbar portion are separated by a distance which is less than the width of the relatively narrow busbar portion, so that the two parts appear to form a continuous busbar portion when viewed from a distance. It is generally considered that unconnected, widely separated, busbar segments on a window give an unsatisfactory aesthetic appearance; if the only difference between a single busbar layout and a corresponding double busbar layout is the presence of a small gap or "break" between the two busbars in the latter, then visually the two busbars appear to be integrated as one.

The invention is especially useful for a window on which it is desired to mount a lamp on the selected area; in particular, the invention finds frequent application in the case of a vehicular rear window ("backlight") on which an additional stop lamp is to be mounted.

The invention will now be further described by way of the following specific embodiments, which are given by way of illustration and not of limitation, and with reference to the accompanying drawings in which:-

Fig. 1 shows an electrically heated window according to a first embodiment of the invention;
Fig. 2 shows an electrically heated window according to a second embodiment of the invention;
Fig. 3 shows an electrically heated window according to a third embodiment of the invention;
Fig. 4 shows a modified version of the first embodiment.

Several elements are common to all four figures, and like reference numerals have been used to denote such elements.

Referring to the drawings, all four figures show electrically heated windows in which it is desired to leave a selected area of the window unheated to enable it to be maintained free for a further item of equipment to be mounted, which in these embodiments is a lamp, more specifically an additional stop lamp. The windows shown happen to be for a rear door of a van or similar load-carrying vehicle, although the invention is applicable to many other types of electrically heated window, as described above. A rear van door window gives rise to an example of the problem described above, as will now be explained.

For reasons of safety, it is becoming increasingly common, and may be required by legislation in certain countries, to mount an additional stop lamp in the rear window of a vehicle. Generally, it is preferred to mount the additional stop lamp (often called a "high-mounted stop lamp") at the top or bottom of the window, and centrally in terms of lateral positioning (i.e., so as to preserve the mirror symmetry of the vehicle). However, for a van (or other vehicle with two rear doors which meet centrally) this presents a problem, since it is clearly not practical to mount a centrally positioned lamp on the meeting line of the doors. In the situation where windows are provided in the doors, a satisfactory compromise is to mount the lamp on one of the windows, as close as possible to the central plane of mirror symmetry of the vehicle.

However, when the window is electrically heated, this may entail positioning the lamp in the heated area of the window, which is normally resistively heated by an array of fine electrical conductors, and in such cases it is considered unacceptable for the conductors to pass in front of the lamp. Consequently, it is desirable to modify the array to keep the area selected for the lamp free of conductors, and as explained above, it is unacceptable simply to shorten the conductors to leave the selected area free, and move the busbar inboard of the lamp, i.e. so that the busbar is on the side of the lamp towards the centre of the window, because this would impair vision through the window and would result in an unattractive appearance.

This difficulty is addressed by the embodiments of the invention which are described below, from which it will be clear to the skilled person how similar situations may be addressed, e.g. on other types of window, or where the selected area is to be used for additional items of equipment other than an additional stop lamp.

Referring to Fig. 1, a first embodiment of the invention is illustrated. An electrically heated window 1 comprises a pane 2 of glazing material, which may be any sheet glazing material, e.g. glass or plastics or a composite of either or both materials. The pane may further be flat or curved, and/or body-tinted or coated; it may also be a laminate of a number of plies of glass and plastics. The pane may in particular be of tempered glass.

Most modern vehicle windows are printed with an opaque band on one face of the pane adjacent its periphery. This band, known in the art as an "obscuration band" is, as the name implies, intended to obscure various components such as the bodywork mounting flange from external view, thereby enhancing the appearance of the vehicle. The window therefore usually has an opaque portion 12 which is covered by the obscuration band and a transparent portion 13. In the drawings, the boundary between the opaque and transparent portions is denoted by a dashed line 18.

The window is heated by a resistive heating element 3 which comprises an array 4 of fine electrical conductors 5 extending across the pane. The conductors may be of any type customarily used in resistive heating elements on windows, for example, they may be lines printed in a conductive ink (such as a silver-containing frit) which is fired onto the glass surface, or they may be thin wires, e.g. of tungsten. Generally, printed lines in conductive ink are preferred for a window comprising a pane wholly of tempered glass, whereas wires are preferred where the pane comprises a laminate, since the wires may be positioned between two of the plies making up the laminate, and thereby fixed in position. A preferred printing technique is screen-printing, but as the various processes for providing the window with a heating element composed of conductors of any of the above-mentioned types are well known, they need not be described further here. The conductors 5 may extend over the pane from side to side, as shown, or they may extend from top to bottom, whichever suits the shape of the pane better.

A selected area 6 of the window is unheated so as to allow it to be maintained free of conductors, and in this embodiment the area 6 has been used to mount a lamp 7 which is a high mounted stop lamp. The array is connected to an electrical supply (in this case the electrical system of a vehicle) by connectors 8 of known type, which are soldered to first and second supply busbars 9 and 10. A further busbar, i.e. connecting busbar 11, is provided to connect the conductors 5 of the array 4 to one another. It should be noted that while it is usual to provide supply busbars 9 and 10 in elongated form as shown, it is possible to arrange the busbars in other ways, e.g. the busbars may take the form of relatively small, possibly circular, areas at which the conductors 5 converge.

As with the conductors, the busbars may be of any type customarily used in connection with resistive heating elements on windows. Typically, when the conductors are printed in conductive ink, the busbars will be formed in the same way. When the conductors are fine metal wires, the busbars are generally formed from metal strip, e.g. tinned copper strip, as is known in the art.

Differing busbar portions are described above as "relatively" wide and "relatively" narrow respectively because the actual breadth of busbar that is generally considered to be "wide" or "narrow" differs according to the material of which the busbar is composed. For instance, when the busbar is formed by screen printing a conduc-

tive ink, its width is normally greater than 10 mm to provide a sufficiently low resistance, often greater than 12 mm, and widths up to 15 mm are frequently used. Even greater widths may be used in certain situations. This type of busbar is considered to be narrow when its width is less than 9 mm, and to make it less obtrusive, it is preferably less than 7 mm wide, more preferably 6 mm wide, or even less than 6 mm wide.

In connection with the above teachings on busbar width, it should be noted that busbars (especially printed busbars) may be tapered or stepped, especially towards their ends, as is described in more detail below. Consequently, references in this specification to busbar width are, unless the context indicates otherwise, references to the width of a part of a busbar (or busbar portion) which is of constant width. Local variations in width, especially a local widening, should be ignored. In the absence of any substantial busbar part of constant width, the reference should be taken to be to the average width of a part of a busbar (or busbar portion). Obviously, the widths of relatively wide and relatively narrow busbar portions are to be considered separately.

Busbars made from metal strip, e.g. tinned copper strip, need not be as wide because these materials have an inherently greater conductivity. A metal strip busbar is considered wide if it is 4 mm wide or greater, and 6 mm is a preferred width for a relatively wide busbar portion. A metal strip busbar less than 4 mm wide is considered narrow, and 3 mm is a preferred width for a relatively narrow busbar portion.

In the drawings, it can be seen that supply busbars 9, 10 and narrow busbar portion 15 are tapered towards one end. Since the conductors 5 are connected to the busbars at intervals, the current flowing in the busbars varies along their length, e.g. it diminishes away from the connectors 8. Owing to the cost of conductive inks containing silver, it is customary to reduce the width of the busbars in corresponding fashion. The width reduction may be achieved in tapering or stepwise fashion; when the busbar is visible, the precise form of width reduction is frequently determined by styling considerations, in fact the latter may discourage any width reduction at all.

As mentioned above, it is not acceptable to keep the selected area free of conductors simply by repositioning the usual connecting busbar inboard of the selected area, for the usual width of a busbar impairs vision through the window, and is aesthetically unacceptable. Furthermore, use of a narrow busbar by itself is also unsatisfactory because its resistance would be higher and it might overheat, presenting a safety hazard. Although it is known to reduce the resistance of printed busbars by plating them, this greatly adds to the cost of the product because it entails an additional process step. Furthermore, aggressive chemicals are used in the plating process, which may give rise to an environmental problem.

According to the invention, connecting busbar 11 has both a relatively wide portion 14 and a relatively narrow portion 15. In this embodiment, the narrow portion joins the wide portion at one of its ends. The narrow portion 15 extends adjacent the selected area 6 and most, but not all, of the conductors 5 are connected to it so that they terminate without extending into the selected area. Although nearly all of the narrow portion 15 is disposed on the transparent portion 13 of the window, it is unobtrusive owing to its narrow width. The relatively wide portion 14 of the busbar is substantially disposed on the opaque portion 12 of the window, that is to say, it is hidden from external view by the obscuration band. In view of the generally rectangular shape of the selected area, it is convenient for the major part of each of the busbar portions 14,15 to extend substantially parallel to the other.

The conductors 5 may be considered as four groups 5a, 5b, 5c and 5d, as shown in Fig. 1. Those conductors in groups 5a and 5b are all connected to first supply busbar 9, which for ease of explanation will be assumed to be at a potential of 12 volts. However, group 5a is connected to the wide busbar portion 14, whereas group 5b is connected to the narrow busbar portion 15. In this way the current flowing through first supply busbar 9 is split between the wide and narrow busbar portions 14 and 15. Clearly, all of this current returns to the second supply busbar 10 via the conductors of groups 5c and 5d, but the distribution of the current depends on the relative resistances of the conductors and of the wide and narrow busbar portions.

It is appropriate to note in this context that the thickness of the conductors may be varied to alter their resistance. For instance, if printed, the conductors may be printed in different widths, typically in the range from 0.4 mm to 1.0 mm. Where the conductors are wires, different thicknesses of wire may be used. Conductor resistance may be varied to preferentially heat certain areas of the window, or to balance the combined resistance of different groups of unequal numbers of conductors to produce a more uniform heating effect.

Still referring to Fig. 1, the current flowing in the conductors of group 5a passes along the wide busbar portion 14, and returns to the second *supply* busbar 10 mainly via the conductors of group 5d but possibly also partly along the conductors of group 5c. Similarly, the current flowing in the conductors of group 5b is most likely to return along the conductors of group 5c, but part of the current may return along group 5d. From Ohm's law, the current will be distributed among the various current paths in inverse relationship to the resistances of those paths, and it will be appreciated that, in view of the above description of how to vary the resistance of individual conductors, the exact path taken by the current will depend on the actual resistances of the various paths in individual cases. However, it will be apparent that the maximum current flowing in the narrow busbar portion 15 is less than it would be if the wide busbar portion 14 were omitted and all the conductors 5 were

connected by means of a narrow busbar. Hence it is the case that the wide busbar portion is connected so as to reduce the current flowing through the narrow busbar portion.

In view of the above description, it will be seen that in particular the current flowing through the small segment of the narrow busbar between group 5c and 5d, which is denoted by reference numeral 16, is likely to be small. In fact, theoretically, if the relative resistances of the conductors and busbar portions happen to have appropriate values, this current may be non-existent. However, it is difficult to design and manufacture heating circuits in which this is achieved in practice. One way of ensuring that the current in segment 16 is zero, and thereby causing the circuit to be a truly parallel circuit in electrical terms, is to design the busbar 11 with a break in segment 16, so that busbar 11 is in fact two separate busbars.

Fig. 1 includes two sub-figures, Fig. 1(a) and Fig. 1 (b) to illustrate this aspect. The small segment 16 of narrow busbar portion is shown greatly enlarged in these sub-figures. In Fig. 1(a), the segment is shown continuous as in the main Fig. 1 drawing, whereas in Fig. 1(b) an optional break 17 has been introduced. While the two resulting ends 16a and 16b serve no purpose in electrical terms, and the break 17 could extend all the way from the last conductor of group 5c to the first conductor of group 5d without altering the electrical behaviour of the circuit, it is preferable from an aesthetic point of view to keep the break small in relation to the width of the busbar so that visual continuity is maintained when the busbar is viewed from a distance typical of normal use.

As mentioned above, use of a narrow busbar alone is unacceptable because of its high resistance, which could lead to overheating of the busbar, and/or to an unacceptably high resistance for the circuit as a whole. The latter would cause the heating effect of the circuit to be reduced, possibly to the extent that the heating effect was no longer sufficient to clear the window of condensation or ice, or at least not in an acceptable time. Electrically heated windows are in fact designed to produce a power density (in terms of heating power divided by area heated) in the vision area in the range from 200 to 1200 watts per square metre at a nominal 12 volts, preferably from 300 to 400 watts per square metre. Heated wiper parking areas may produce power densities up to 3000 watts per square metre for rapid freeing of frozen wiper blades. It is the use of the relatively wide busbar portion that allows such levels of power density still to be obtained despite the use of the relatively narrow busbar portion in a visually sensitive part of the window. In calculations of power density, the area covered by the busbars should not be included, since the busbars are designed to minimise the heat they produce.

Fig. 2 shows a second embodiment of electrically heated window according to the invention, in which the selected area is again used to mount a lamp, but the lamp is larger in relation to the heated area of the window and to the window itself, or of course it could be vice versa.

Many aspects of this embodiment are the same as in the first embodiment, and so need not be described again. However the lamp 20, and hence the area 21 selected for mounting it, are relatively larger and so a different arrangement for the connecting busbar 22 is required. It is desirable for the narrow busbar portion 23 of connecting busbar 22 to extend along the entire length of lamp 20 to allow all the conductors 5 to be connected to it, and thereby provide electrical continuity from the first supply busbar 9 to the second supply busbar 10. As a result of its increased length, it is especially desirable in this embodiment for the current to take the shortest possible path along the narrow busbar portion 23.

The narrow busbar portion 23 may be divided by breaks 17, and so the connecting busbar 22 may in fact be in two parts, 22a and 22b, forming two separate busbars which are in parallel with each other in electrical terms. Busbar 22a includes a wide busbar portion 24 and part of the narrow busbar portion 23, whereas busbar 22b consists entirely of part of the narrow portion 23. In this embodiment, current carried by conductor group 5a passes along busbar 22a, including along wide busbar portion 24 and returns along group 5d. Current carried by group 5b passes along the busbar 22b and returns along conductor group 5c. In this way, it is not necessary for current to flow along the entire length of narrow busbar portion 23, so the high resistance of this portion does not present a problem in practice.

In fact, if the relative resistances of the various conductors and busbar portions are appropriately selected, it is still possible for the breaks 17 to be dispensed with. This is because, for example, the lowest resistance return path for the majority of the current carried by conductor group 5a would in any case be via the conductors of group 5d, providing that the resistance of the path via wide busbar portion 24 is low enough. The provision of the breaks 17 at the points shown in Fig. 2 in effect constrains the current to flow along the paths along which it would in fact flow anyway if the relative resistances of the conductors and busbar portions have been appropriately chosen. Use of the breaks thereby ensures the desired result while obviating the need for complicated analysis of the current flow in the busbar.

Fig. 3 shows a third embodiment of the invention, in which the lamp is smaller in relation to the heated area of the window, or vice versa, than in the first and second embodiments. Fig. 3 also shows how a heated parking area for a window wiper may be added to the circuit, although this is not unique to the third embodiment

Again, many elements of the electrically heated window shown in Fig. 3 are the same as in Figs. 1 and 2, and so will not be described again. The selected area 30 is again used to mount a lamp 31, and the conductors 5 are connected together by a connecting busbar 32

having a wide portion 33 and a narrow portion 34. The narrow portion 34 joins the wide portion 33 at one of the latter's ends 35, and joins it again at a point 36 intermediate its ends, so that the narrow portion and part of the wide portion together form a loop around the selected area 30. The loop configuration allows current a greater choice of return paths.

The conductors 5 may be considered to be in two groups : a first group 5e, comprising the conductors connected to the first supply busbar 9; and a second group 5f, comprising the conductors connected to the second supply busbar 10. The conductors of group 5e extend all the way from the supply busbar 9 to the wide portion 33 of the connecting busbar 32, whereas the conductors of group 5f (about half of the total number of conductors) stop short of the wide busbar portion 33 so as to leave the selected area 30 free of conductors, and the narrow busbar portion 34 is provided to connect these conductors to the circuit without detracting from the appearance of the window.

Still assuming for the sake of explanation that first supply busbar 9 is at 12 volts, current flows outwards from busbar 9 along the conductors of group 5e, along connecting busbar 32, and returns along the conductors of group 5f. Because of the loop configuration of the narrow busbar portion 34 together with part of the wide busbar portion 33, none of the current need flow more than halfway round the narrow busbar portion 34 to reach a 5f conductor. It will therefore be understood that it is again possible to introduce a break in the narrow busbar portion, at the point marked 37, if the relative resistances of the conductors and busbar portions are selected appropriately. However the advantage of the loop configuration is then lost.

Fig. 3 also shows a heated wiper parking area 40, which is provided by an extra conductor 41 extending from the connecting busbar 32 to the second supply busbar 10. A wiper may be mounted with its spindle passing through hole 42, so that the blade of the wiper rests in the area 40 when not in use. The conductor 41 is arranged to repeatedly curve back and forth, e.g. in a wavy or sinusoidal fashion, in the area 40 to increase the area heated and allow for variations in the rest position of the wiper blade. Such a heated wiper parking area is known in the art, and it has merely been mentioned here because it is frequently preferred to include one in an electrically heated window for a vehicle. The extra conductor or conductors may be connected to either the narrow or wide portion of the connecting busbar according to what is most convenient for each individual circuit layout. The extra conductor will of course need to be taken into account when allotting resistance values to all the conductors in the heating element. For instance, in the window shown, it may be desirable for uniform heating to arrange for the resistance of the conductor group 5e (i.e. the overall resistance of all 6 conductors in parallel) to be equal to the resistance of group 5f and conductor 41 combined.

A heated wiper parking area may similarly be added to the first and second embodiments described above, and Fig. 4 shows the first embodiment modified to include a heated wiper parking area as shown in Fig. 3. In the Fig. 4 version, the connectors 8 on the supply busbars 9 and 10 have been positioned at the opposite ends of the busbars to the Fig. 1 version, thereby allowing the connectors to be closer to each other, which may facilitate external connection, e.g. to the wiring loom of a vehicle. Consequently the supply busbars 9 and 10 taper in the opposite direction.

Claims

1. An electrically heated window comprising a pane of glazing material, at least two spaced busbars disposed on the pane and a resistive heating element extending over the pane from one busbar to the other busbar, said busbars connecting the heating element to an external power source, the window being heated by the passage of current through the heating element,
characterised in that the heating element is arranged to leave a selected area of the window unheated, and that at least one of the busbars comprises at least two portions whereby the first portion of the busbar is narrow relative to the second portion, that the relatively narrow busbar portion extends adjacent the selected area and part of the heating element is connected to the relatively narrow busbar portion so that the heating element terminates without extending into the selected area, and that the relatively wide busbar portion is connected so as to reduce the electric current which flows through the relatively narrow busbar portion.

2. A window as claimed in claim 1, wherein the window comprises a transparent portion and an opaque portion, the relatively narrow busbar portion being disposed substantially on the transparent portion.

3. A window as claimed in claim 2, wherein the relatively wide busbar portion is disposed substantially on the opaque portion.

4. A window as claimed in claim 2, wherein the relatively wide busbar portion extends adjacent the opaque portion.

5. A window as claimed in any preceding claim, wherein the resistive heating element comprises an array of fine electrical conductors, and at least some of the conductors extend towards the selected area.

6. A window as claimed in any preceding claim, wherein the resistance of the heating element is such that the power density, calculated over the heated area,

at a nominal potential difference of 12 volts, is in the range from 200 to 1200 watts per square metre.

7. A window as claimed in claim 6, wherein the power density is in the range from 300 to 400 watts per square metre.

8. A window as claimed in any preceding claim, wherein the at least one busbar comprises two busbars, one of the busbars being at least partly connected in parallel with the other busbar in electrical terms.

9. A window as claimed in claim 8, wherein one of the busbars includes part of the relatively narrow busbar portion, and the other busbar includes both the relatively wide busbar portion and the remaining part of the relatively narrow busbar portion.

10. A window as claimed in claim 9, wherein the two parts of the relatively narrow busbar portion are separated by a distance which is less than the width of the relatively narrow busbar portion, so that the two parts appear to form a continuous busbar portion when viewed from a distance.

11. A window as claimed in any preceding claim, wherein the busbar is printed in conductive ink and the width of the relatively narrow busbar portion is less than 9 mm.

12. A window as claimed in claim 11, wherein the width is less than 7 mm.

13. A window as claimed in claim 12, wherein the width is less than 6 mm.

14. A window as claimed in any preceding claim, wherein the busbar is printed in conductive ink and the width of the relatively wide busbar portion is greater than 10 mm.

15. A window as claimed in claim 14, wherein the width is greater than 12 mm.

16. A window as claimed in any preceding claim, wherein the relatively narrow busbar portion joins the relatively wide busbar portion at one of its ends.

17. A window as claimed in any one of claims 1 to 15, wherein the relatively narrow busbar portion joins the relatively wide busbar portion at a point intermediate its ends.

18. A window as claimed in any preceding claim, wherein the major part of each of the busbar portions extends substantially parallel to the other.

19. A window as claimed in any preceding claim, wherein part of the at least one busbar is in the form of a loop.

20. A window as claimed in any preceding claim, wherein a lamp is mounted on the selected area of the window.

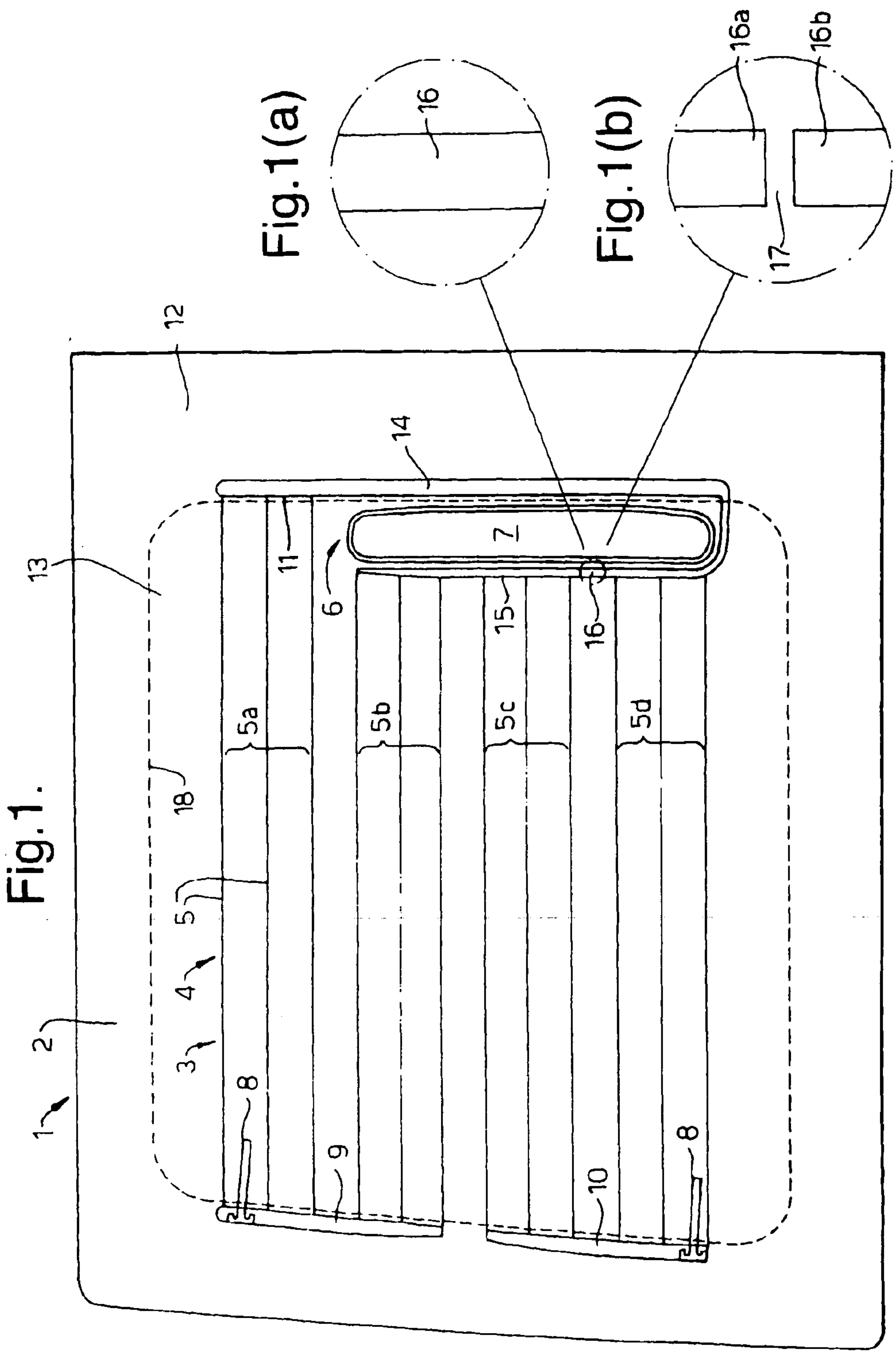
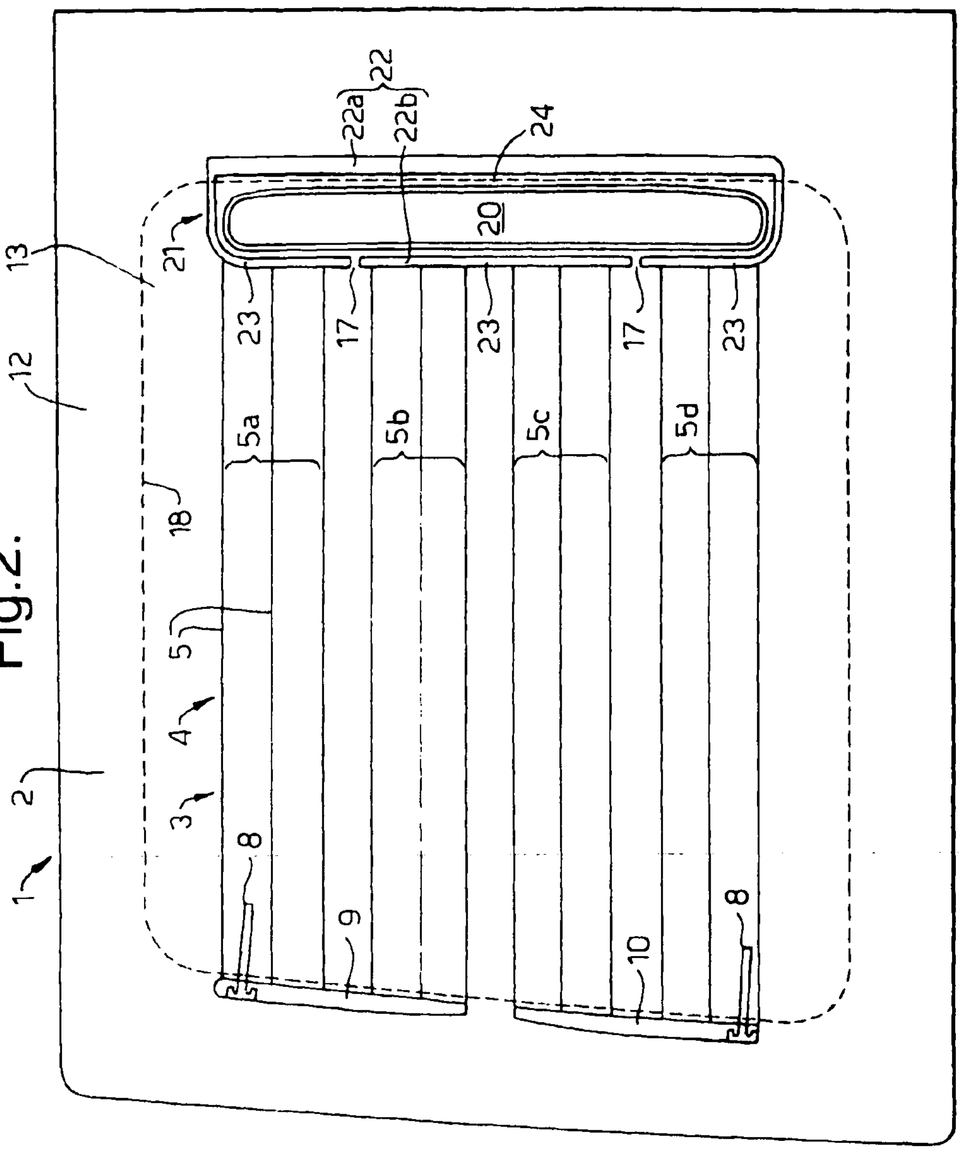


Fig.1.

Fig.1(a)

Fig.1(b)

Fig.2.



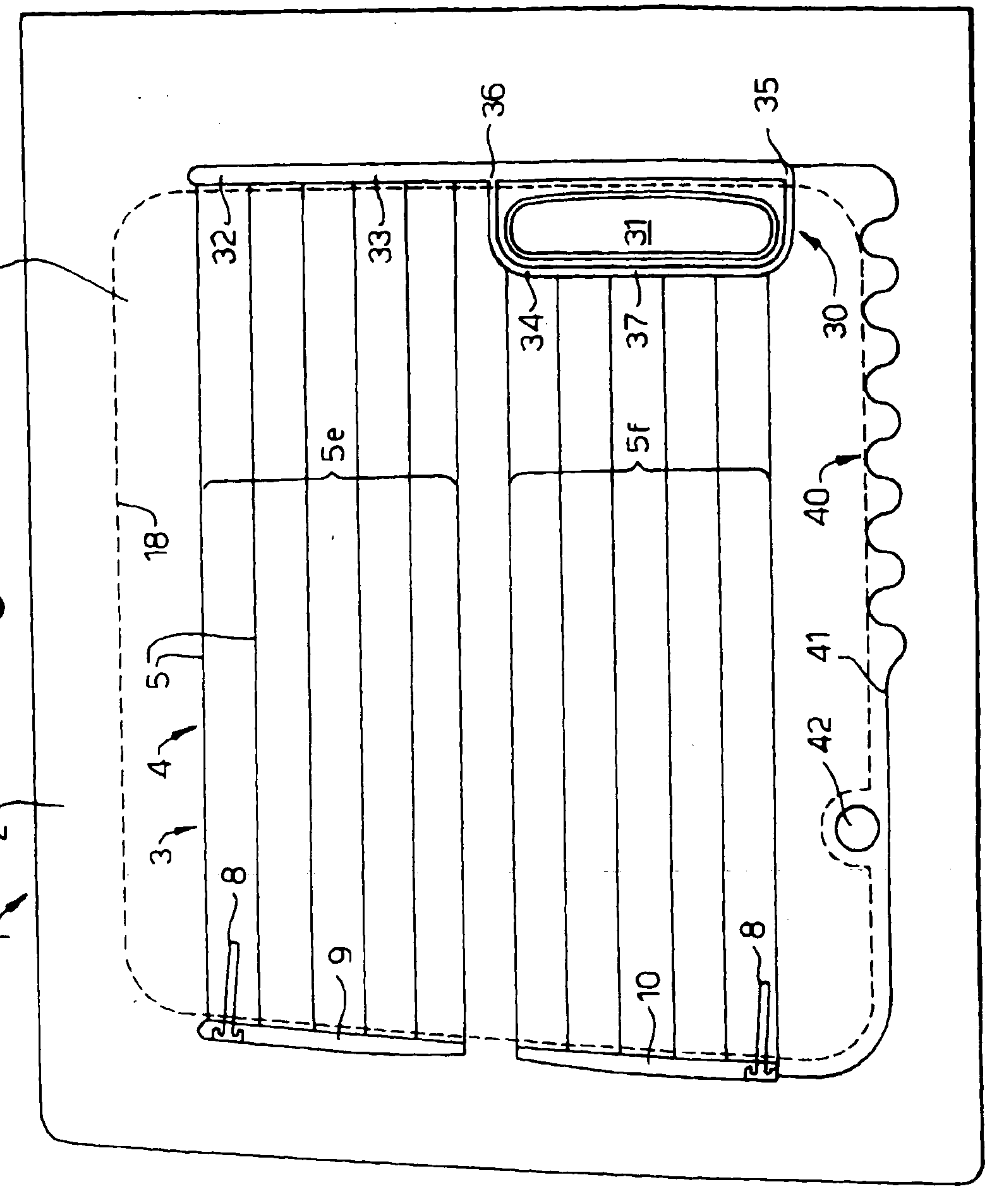


Fig.3.

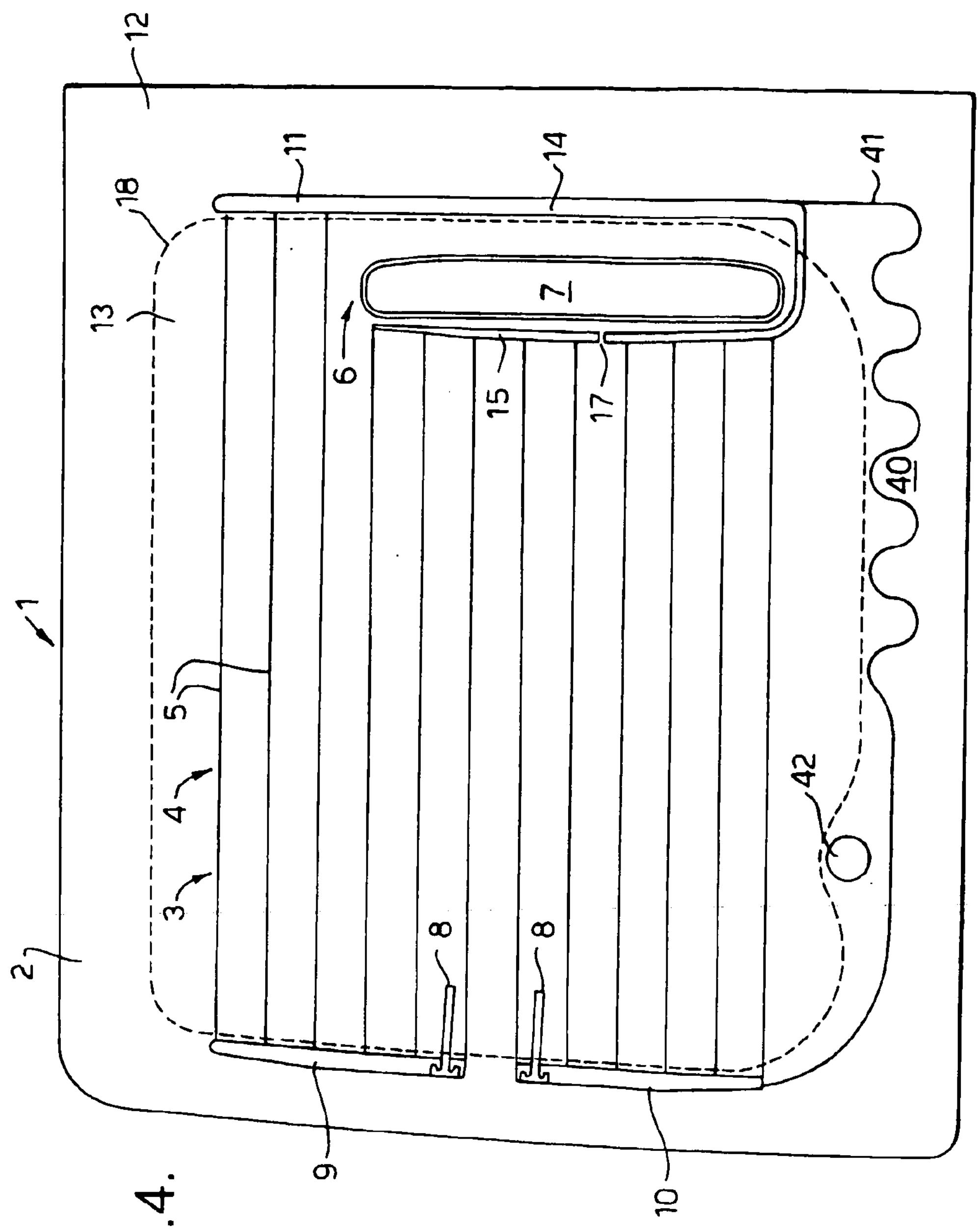


Fig.4.